

opinions; that we must be prepared to receive fresh ideas from our new views of the action of intense heat on gases and meteorites.

I have only one point to add to my own observation (at two, not ten, minutes past six, as misprinted), that the object, when nearest, presented through its length (but rather below than above) a remarkable "boiling" appearance (as seeds in a capsule), while the edges appeared smooth and quiet.

The Rookery, Ramsbury, February 20 ALFRED BATSON

### Aurora

A NEWSPAPER paragraph that has come under my notice describes "a strange phenomenon" seen at Brixham on Thursday morning at 1.30—the 15th instant is to be inferred from the date of the paper. It would seem to have been an aurora—yet another example of exceptional auroral activity attendant on the passage of large sun-spots, as there was a spot of importance approaching the sun's central meridian at the time. Any definite information concerning this particular manifestation, or indeed aurora generally near the date in question, appears worthy of a place in your journal. The sun-spot maximum is passing—perhaps past—and such opportunities should not be lost.

February 24

F. B. E.

### DIURNAL VARIATION OF THE VELOCITY OF THE WIND ON THE OPEN SEA, AND NEAR AND ON LAND<sup>1</sup>

DURING the three-and-a-half years' cruise of the *Challenger*, ending with May, 1876, observations of the force and direction of the wind were made on 1202 days, at least twelve times each day, of which 650 days were on the open sea, and 552 days near land. The observations of force were made on Beaufort's Scale, (0–12) being the scale of wind-force observed at sea. The five oceans have been examined separately, viz., the North and South Atlantic, the North and South Pacific, and the Southern Ocean, and thereafter the results grouped together. The mean diurnal periodicity in the force of the wind on the open sea and near land respectively is shown on Fig. 1, where the figures on the left are Beaufort's Scale, and those on the right their equivalents in miles per hour. The solid line represents the mean force on the open sea, and the dotted line the mean force near land.

As regards the open sea, it is seen that the diurnal variation is exceedingly small, showing only two faintly-marked maxima about midday and 2 a.m. respectively. On examining, however, the separate means for the five oceans, no uniform agreement whatever is observable among their curves. The slight variations which are met with are different in each case, not one of the maxima or minima being repeated at the same hours in more than two of the five oceans. It follows, therefore, that the force of the winds on the open sea is subject to no distinct and uniform diurnal variation. The difference between the hour of least and that of greatest mean force is less than a mile per hour.

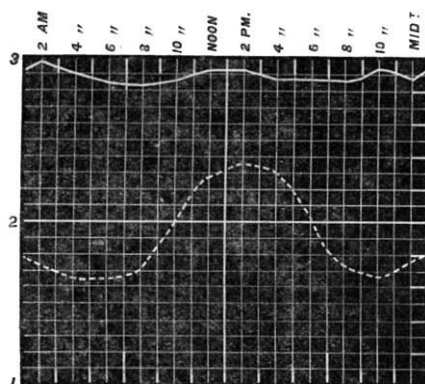
Quite different is it with the winds encountered by the *Challenger* near land, where the observations of the force of the wind give a curve as pronouncedly marked as the ordinary diurnal curve of temperature. The minimum occurs at 2 to 4 a.m., and the maximum from noon to 4 p.m., the absolute highest being at 2 p.m. The curve constructed for each of the five oceans, from the observations near land, gives one and the same result, viz., a curve closely agreeing with the curve of diurnal temperature.

The 650 daily observations on the open sea give a mean velocity of  $17\frac{1}{2}$  miles per hour, but the 552 near land give a velocity of only  $12\frac{1}{2}$  miles per hour. The difference is greatest at 4 a.m., when it amounts to up-

wards of 6 miles an hour, but is diminished as the temperature rises, till at 2 p.m. it is less than 3 miles an hour.

At Mauritius, which is situated within the south-east trades, the minimum velocity of the wind is 9.7 miles per hour, occurring from 2 to 3 a.m., from which hour it rises to the maximum 18.5 miles from 1 to 2 p.m., the influence of the sun being thus to double the wind's velocity. At Batavia, situated in a region where the mean barometric gradient is much smaller, the differences are still more decided. From 1 to 6 a.m., 85 per cent. of the whole of the observations are calms, whereas from noon to 2 p.m. only 1 per cent. are calms. In all months the minimum velocity occurs in the early morning, when the temperature is lowest, and the maximum from 1 to 3 p.m., when the temperature is highest. At Coimbra, the mean maximum hourly velocity in summer is five times greater than the minimum velocity, whereas in winter it is only about a half more. At Valencia, in the south-west of Ireland, one of the stormiest situations in western Europe, the three summer months of 1878 gave a mean hourly velocity of 13.3 miles per hour, the minimum oscillating from 10 to 11 miles an hour from 9 p.m. to 6 a.m., and the maximum exceeding 16 miles an hour from 11 a.m. to 5 p.m. The absolutely lowest hourly mean was 10 miles at 11 p.m., and the highest 18 miles at 1 p.m., the velocity about midday being thus nearly double that of the night. The results of observa-

FIG. 1.



tions at many other places might be added to these, including those published by Wild, Hann, Köppen, Hamberg, and others, which go to establish the fact that the curves of the diurnal variation of the velocity of the wind generally conform to the diurnal curves of temperature. The curves of the diurnal variation are most strongly marked during the hottest months. The maximum velocity occurs at 1 p.m., or shortly thereafter, being thus before the maximum temperature of the day (occurring therefore at the time when insolation is strongest); and the minimum in the early morning, when the temperature falls to the lowest, or when the effects of terrestrial radiation are at the maximum. The rule appears to hold good with all winds, whatever be their direction, as shown by Hamberg. The exceptions to this rule are so few, and of such a nature, that they are in all probability attributable to causes more or less strictly local.

With respect to cloud, Hann has pointed out that for a number of places the mean maximum hourly velocity is 102 per cent. above that of the minimum with clear skies; 77 per cent. with skies half covered with clouds; and 50 per cent. with skies wholly covered. At Vienna, however, these rates of increase are, for clear skies, 101, and half-covered skies, 66 per cent., whereas when the sky is overcast the variation becomes irregular and but faintly marked. Hann has also examined the Vienna observations of the wind on those days when the velocity

<sup>1</sup> Part of this article is abridged from a forthcoming volume of the "Reports" of H.M.S. *Challenger*, by permission of the Lords Commissioners of H.M. Treasury.

did not exceed 30 kilometres per hour and on the days when this rate was exceeded, and finds the diurnal periodicity well marked with light and moderate winds, but irregularly and only slightly marked with strong winds and stormy weather.

In inquiring into the remarkable facts regarding the variation in the diurnal velocity of the wind observed in all climates, attention is first drawn to the two curves of Fig. 1, showing the observations of wind-force made on board the *Challenger* during the cruise. As regards the open sea, the diurnal curve shows practically no variation. The whole of the observations of the surface temperature of the North Atlantic made by the *Challenger* have been discussed, with the result that the daily range is only  $0^{\circ}7$ . Hence the statement may be regarded as substantially correct, that over the ocean the atmosphere rests on a floor the temperature of which is all but constant day and night; and, so far as concerns the generation of ascending aerial currents from a heated surface, practically constant.

On approaching the land, however, the daily range of the temperature of the air over the sea becomes materially augmented, the daily range being  $4^{\circ}3$ , and, as all observation shows, the temperature over land still more so. Now, bearing in mind that the temperature has risen above its daily mean at 10 a.m., and fallen below it at 10 p.m., an examination of the curve of velocity near land in Fig. 1 reveals the fact that the increase in the diurnal velocity of the wind is entirely restricted to those hours of the day when the temperature is above the daily mean, and the maximum velocity is reached at the hour when insolation, or the sun's heating power, is strongest. The phenomenon of the diurnal variation in the wind's velocity is thus associated in the closest manner with the temperature of the surface on which the air rests. Where there is practically no variation, as in the temperature of the surface of the sea, there is no variation in the velocity; but where, as on land, the temperature of the air has a strongly-marked daily period, the wind-force also is strongly marked, and the increase rises and falls with the degree of insolation on the surface. Further, the velocity increases, not with the increase in the temperature of the air, but with the heating of the surface; in other words, with the conditions on which ascending aerial currents depend.

It is also to be observed, as regards the curves of the five oceans, that they show in each case and at all hours of the day a greater velocity of the wind on the open sea than near land.

The following are the mean and extreme hourly velocities, in miles per hour, for the five oceans:—

	North Atlantic.	South Atlantic.	North Pacific.	South Pacific.	Southern Ocean.
	Miles.	Miles.	Miles.	Miles.	Miles.
Mean hourly velocity on open sea ... ..	18.0	18.1	14.5	16.2	23.5
Mean hourly velocity near land ... ..	15.0	14.7	9.6	11.0	17.6
Difference ... ..	3.0	3.4	4.9	5.2	5.9
Highest mean hourly velocity near land ... ..	17.0	16.4	11.6	13.7	20.8
Lowest mean hourly velocity near land ... ..	13.1	13.0	10.0	9.3	14.3
Diurnal variation near land ... ..	3.9	3.4	1.6	4.4	6.5

Thus the winds are lightest on the North Pacific, and strongest on the Southern Ocean, and these oceans show respectively the least and the greatest diurnal variation in the force of the wind on nearing land.

From the number and character of the two sets of

observations, it may be assumed, without risk of error, that the open-sea and the near-land winds, summarised and represented in Fig. 1, were atmospheric movements resulting from mean barometric gradients substantially equal to each other. From the above table it is seen that in each of the oceans the mean velocity near land is less than that on the open sea, the two extremes being the North Atlantic, with a difference of 3.0 miles, and the Southern Ocean with a difference of 5.9 miles; and that even the maximum velocity during the day is always less than the velocity on the open sea. The slight rise in the near-land curve during night is probably wholly caused by the land-breezes felt on board the *Challenger* when near land. In strictly inland places, tolerably well situated for making observations of the wind, this feature does not appear in the curve, and there the velocity falls to the diurnal minimum during the period of lowest temperature, or when the effects of terrestrial radiation are most felt on the surface of the ground.

From these results it follows that, so far as concerns any direct influence on the air itself, considered apart from the floor or surface on which it rests, solar and terrestrial radiation do not exercise any influence in causing the diurnal increase of the velocity of the wind with the increase of the temperature of the air; or if there be any influence at all, such influence is altogether insignificant, as the observations of the *Challenger* on the five great oceans of the globe conclusively prove. The same observations show that on nearing land the wind is everywhere greatly reduced in force, the retardation being due chiefly to friction, and to the viscosity and inertia of the air in relation to the obstructions offered by the land to the onward course of the wind. The retardation is greatest when the daily temperature is at the minimum, and it is particularly to be noted that though the temperature rises considerably, yet no marked increase in the velocity sets in till about 9 a.m., when the temperature has begun to rise above the daily mean. From this time the increase is rapid. The maximum velocity is reached immediately after the time of strongest insolation, and falls a little, but only a little, during the next three to five hours, according to season, latitude, and position. The velocity is low during the hours when the temperature is lower than the daily mean, and the least velocity occurs early in the morning. Even the maximum near land falls considerably short of the velocity which is steadily maintained over the open sea by night as well as by day.

The period of the day when the wind's velocity is increased is thus practically limited to the time when the temperature is above the daily mean, and the surface superheated, and the influence of this higher temperature is to counteract to some extent the retardation of the wind's velocity resulting from the causes already stated. The results show that the increase in the diurnal velocity of the wind is due to the superheating of the surface of the ground, and to the ascensional movement of the air consequent thereon, which tend to reduce the effects of friction and viscosity of the air. It is of importance in this connection to keep in view the fact, shown by hourly observations made at the instance of the Marquis of Tweeddale in 1867 on the temperature of the soil and air, that in cloudy weather a temperature much higher than that of the air near the ground was radiated from the clouds down upon the earth's surface (*Journal Scottish Meteorological Society*, vol. ii. p. 280). Hence in cloudy weather the superheating of the surface-layer of the ground will often take place, the greatest degree of heating being under an overcast sky, where the cloud-covering is of no great thickness, and the temperature of the clouds themselves is much higher than that of the surface of the earth. On the other hand, little or rather no heating will take place, when the cloud-screen which overspreads the sky is of great thickness, and the



temperature of the clouds is not greater than that of the surface; and when the temperature of the cloud-screen is lower than that of the surface, the temperature of the latter will fall. It is scarcely necessary to remark that in discussing the influence of cloud on the diurnal periodicity of the wind's velocity, only such means are of real value as are calculated from a very large number of observations.

During the night, when terrestrial radiation is proceeding, the temperature of the surface falls greatly, and instead of an ascensional movement in the lowermost stratum of the air, there is, on the contrary, a tendency towards, and, if the wind be light, an actual descensional movement down the slopes of the land. The effects of friction being thus intensified, the velocity of the wind falls to the daily minimum during these hours.

ALEXANDER BUCHAN

*EPHEMERIS OF THE GREAT COMET, b 1882*  
(Communicated by Vice-Admiral Rowan, Superintendent  
U.S. Naval Observatory)<sup>1</sup>

		GREENWICH MEAN NOON					
		R.A.	Decl.	Log. r.	Log. Δ.		
1883.		h. m. s.	° ' "				
Feb.	10 <sup>o</sup> .	6 0 37.8 ...	-19 41 17 ...	0.48137 ...	0.38890		
	14 <sup>o</sup> .	5 57 40.4 ...	18 40 13 ...	0.48909 ...	0.40520		
	18 <sup>o</sup> .	5 55 19.7 ...	17 41 17 ...	0.49669 ...	0.42132		
	22 <sup>o</sup> .	5 53 32.7 ...	16 44 35 ...	0.50413 ...	0.43723		
	26 <sup>o</sup> .	5 52 14.7 ...	15 50 14 ...	0.51133 ...	0.45282		
March	2 <sup>o</sup> .	5 51 24.4 ...	14 58 16 ...	0.51841 ...	0.46817		
	6 <sup>o</sup> .	5 50 58.7 ...	14 8 43 ...	0.52532 ...	0.48322		
	10 <sup>o</sup> .	5 50 54.8 ...	13 21 37 ...	0.53200 ...	0.49790		
	14 <sup>o</sup> .	5 51 12.3 ...	12 37 0 ...	0.53861 ...	0.51231		
	18 <sup>o</sup> .	5 51 47.9 ...	11 54 52 ...	0.54508 ...	0.52635		
	22 <sup>o</sup> .	5 52 39.5 ...	11 15 10 ...	0.55135 ...	0.53995		
	26 <sup>o</sup> .	5 53 46.1 ...	10 37 56 ...	0.55751 ...	0.55316		
	30 <sup>o</sup> .	5 55 6.1 ...	10 3 6 ...	0.56354 ...	0.56594		
April	3 <sup>o</sup> .	5 56 38.1 ...	9 30 34 ...	0.56944 ...	0.57828		
	7 <sup>o</sup> .	5 58 20.9 ...	9 0 19 ...	0.57520 ...	0.59015		
	11 <sup>o</sup> .	6 0 13.9 ...	-8 32 21 ...	0.58090 ...	0.60158		

Note.—In the published elements  $\phi$  should be  $89^{\circ} 13' 42''$  instead of  $89^{\circ} 7' 42''$ .

Washington, February 10

E. FRISBY,  
Prof. Math., U.S.N.

*ILLUSTRATIONS OF NEW OR RARE ANIMALS  
IN THE ZOOLOGICAL SOCIETY'S LIVING  
COLLECTION*<sup>2</sup>

XI.

29. **THE CAPE SEA-LION** (*Otaria pusilla*).—It is a singular and as yet unexplained fact in geographical distribution, that while the Sea-lions amongst Mammals and the Albatrosses amongst Birds are confined to the South Atlantic Ocean, both these groups reach up to high northern latitudes in the Pacific. In the Atlantic, no Albatross is seen "north of the line," whereas these birds are familiar objects on the coasts of both California and Japan. No Sea-lion is met with in the Atlantic until we get to the Cape on one side and the La Plata on the other, but these animals are well-known objects at San Francisco, and the great supply of their much-valued furs comes from the far northern territory of Alaska.

The Sea-lion first became an inhabitant of our Zoological Gardens, and thus known to Europe in a living state, in 1866, when a French seaman, François Lecomte, brought to this country an example of the Patagonian species (*Otaria jubata*), and exhibited it to the public. The remarkable form of this animal, its extreme docility, and its agile movements attracted great attention, and

led to its acquisition by the Zoological Society, in whose Gardens it quickly became an established favourite. Upon the death of this individual in the autumn of the same year, the Council of the Society determined to send out Lecomte, who had entered their service in charge of it, to the Falkland Islands, in order to obtain other specimens. Lecomte returned to this country in August, 1867, but owing to various unforeseen circumstances only succeeded in landing alive one of the four Sea-lions with which he had started from Port Stanley. This animal, young and small on its arrival, threw well under Lecomte's careful management, and soon supplied the void occasioned by the death of the original specimen. Like its predecessor, it exhibits extraordinary agility in the water, and catches the fishes thrown to it for food both above and below the surface with unerring aim.

Four years subsequently, in 1871, the Society received from Sir Henry Barkly, then Governor of the Cape Colony, a present of a young specimen of the Cape Sea-lion, of which we now give an illustration (Fig. 29). Like its Patagonian relative, the Cape Sea-lion is a female, and although quite adult, does not attain the dimensions of the male sex of these animals. In general appearance, shape, and form, the two species are very similar, and present little obvious differences to the casual observer, except that the ear-lobe is longer in the Cape animal. To the two females has recently been added a young male of the Patagonian form, and the three individuals now live together in the narrow limits of their basin in the greatest harmony, forming one of the most attractive groups in the Regent's Park Gardens. Little has been recorded of the mode of life of the Sea-lion in a state of nature, but Mr. E. L. Layard in his "Catalogue of the South African Museum," tells us that it "is abundant along the whole of the coasts of the colony, and has given its name to numerous bays, islands, and capes, of which 'Robben' Islands near Cape Town is perhaps the best known.

"It resorts to these places in great numbers for breeding purposes, and is sought for and slain for the sake of its fur and oil. The male is said to be maned, and to much exceed the female in size, but though double the market value of the skin has been offered by the Museum for a skin of the male of this common animal, as it is not the custom of the sealers to take the skin off, leaving in the head and feet, we have been unable to procure one."

As regards the habits of some of the other members of this genus, which are of the most extraordinary character, we have now ample details concerning the North Pacific species in a very interesting and well illustrated work prepared by Mr. Henry W. Elliott on the Seal Islands of Alaska and their productions.<sup>1</sup>

Soon after the Sea-lions were established in the Zoological Gardens in this country, specimens of these animals were obtained by the principal Gardens on the Continent, and basins built for the exhibition of their aquatic evolutions. But the examples on the Continent, as well as those in the Aquarium at Brighton, all belong to one of the North Pacific species of Sea-lion (*Otaria californiana*), which is found in enormous multitudes upon the Pacific coast. Of the South African species now figured, the example in our Zoological Society's Gardens is the only one yet brought alive to Europe.

30. **BLANFORD'S SHEEP** (*Ovis blanfordi*).—Every high mountain-tract in Northern and Central Asia appears to be occupied by a distinct form of Wild Sheep (*Ovis*), while single outliers of the same genus are found far to the west in Sardinia and to the east in North America. Some of these animals, such as the celebrated "Ammon," of Ladakh (*Ovis hodgsoni*) and the Snow-sheep of Kamschatka (*O. nivicola*), attain a magnificent size and

<sup>1</sup> Computed from elements (NATURE, vol. xxvii. p. 225) and reduced to the mean equinox 1883<sup>o</sup>.

<sup>2</sup> Continued from p. 154.

<sup>1</sup> A Monograph of the Seal Islands of Alaska. By Henry W. Elliott. Reprinted, with additions, from the Report of the Fishery Industries of the Tenth Census. 4to. Washington, 1882.